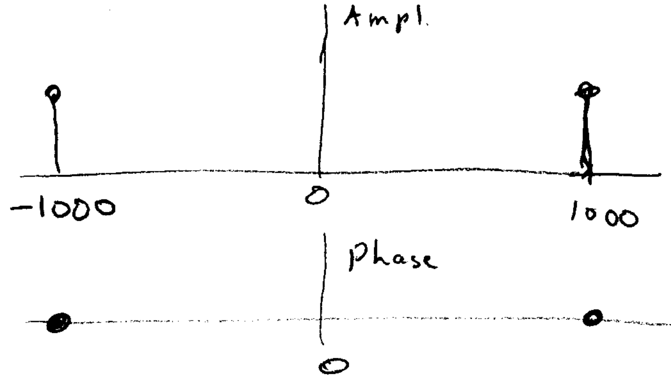
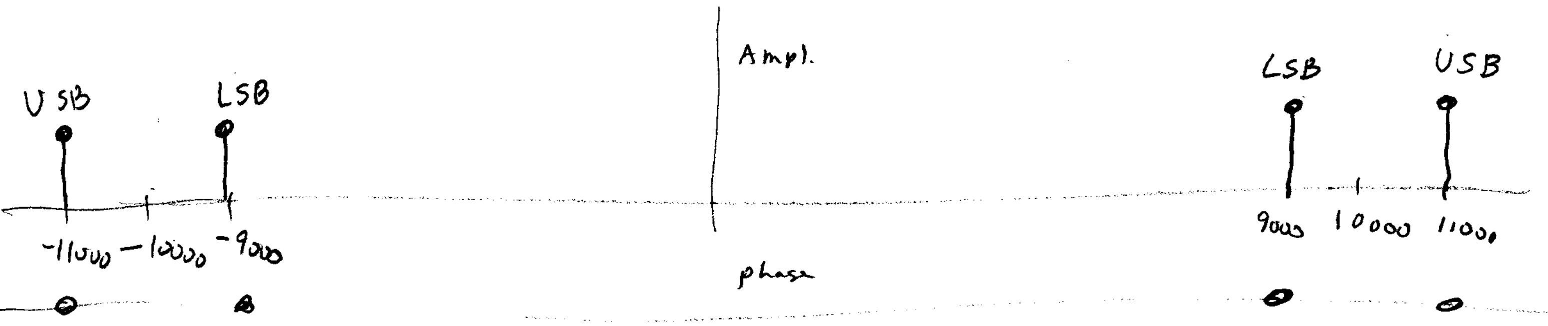
4.2-1 (i) cos 1000t

(a) spectrum of m(t)



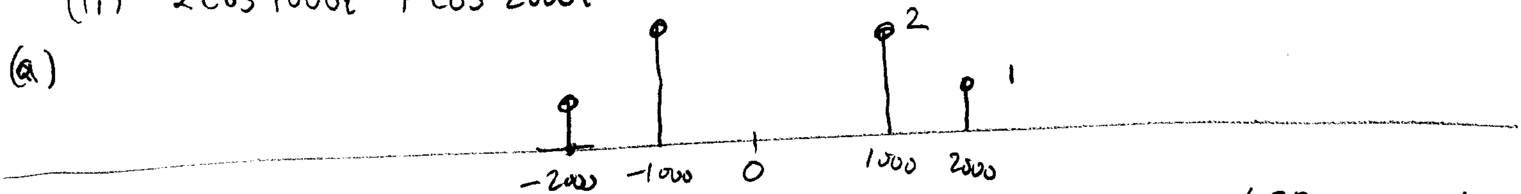
(b) Spectrum of m(t) cos 10000t

(c) identify USB, LSB

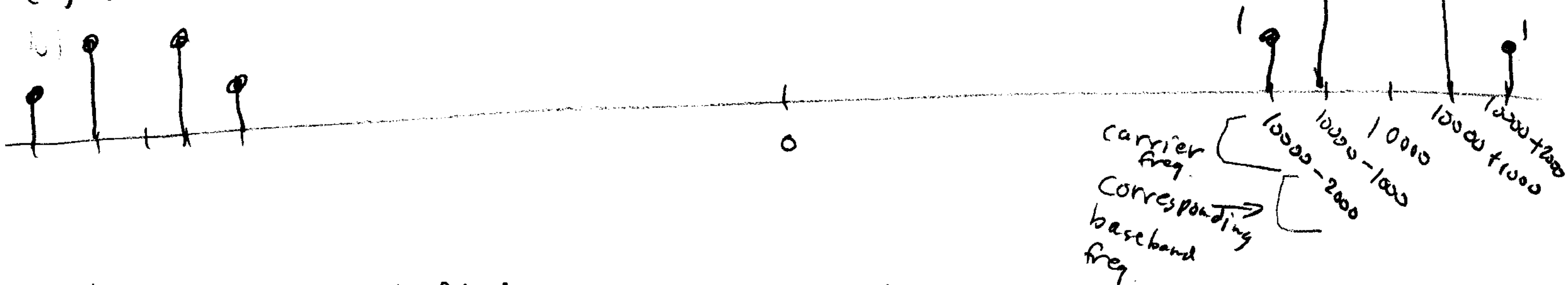


(ii) 2 cos 1000t + cos 2000t

(a)



(b,c)



baseband is shifted so 0 is at ± 10000.

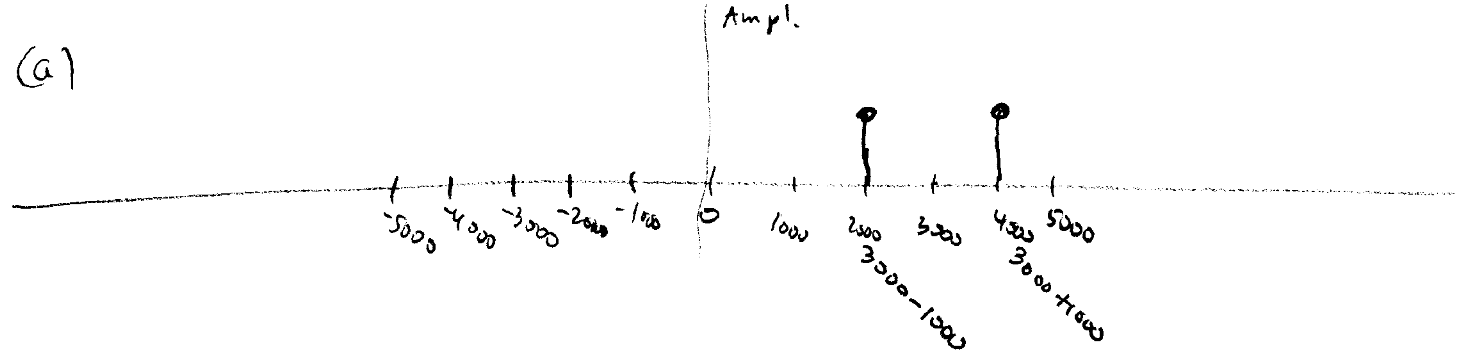
modulated signal has sum + difference,

but both inputs do not appear at output.

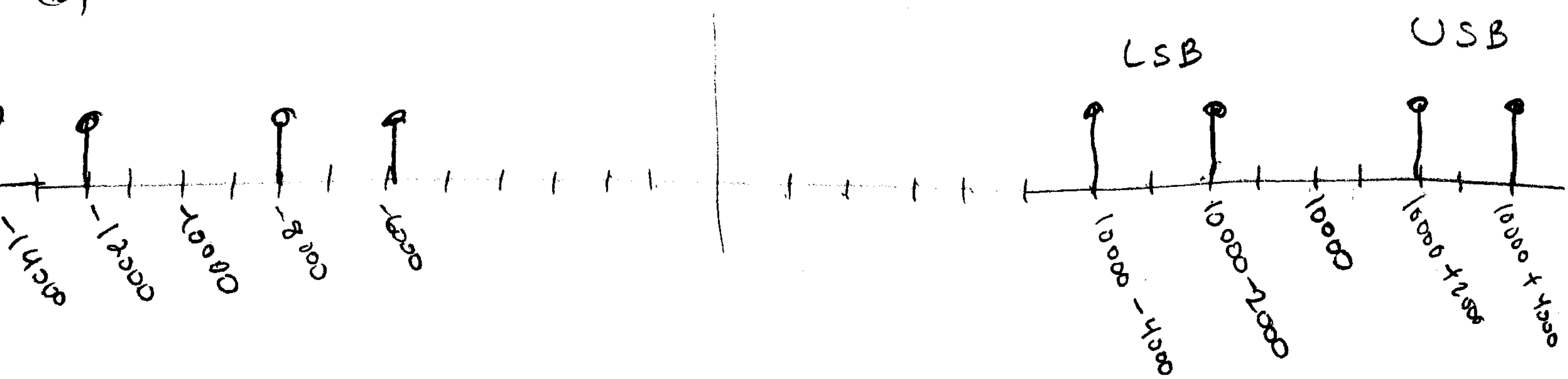
4.2-1

(iii) $\cos \overset{\omega_1}{1000} t \cos \overset{\omega_2}{3000} t$

(a)



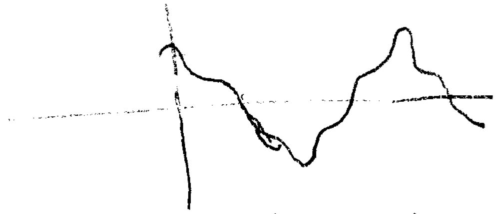
(b)



m(t) is already a modulated signal, with components at 2000 (LSB, $\omega_2 - \omega_1$) and 4000 ($\omega_2 + \omega_1$).

The DSB-SC signal shifts that spectrum so $0 \to 10000$.

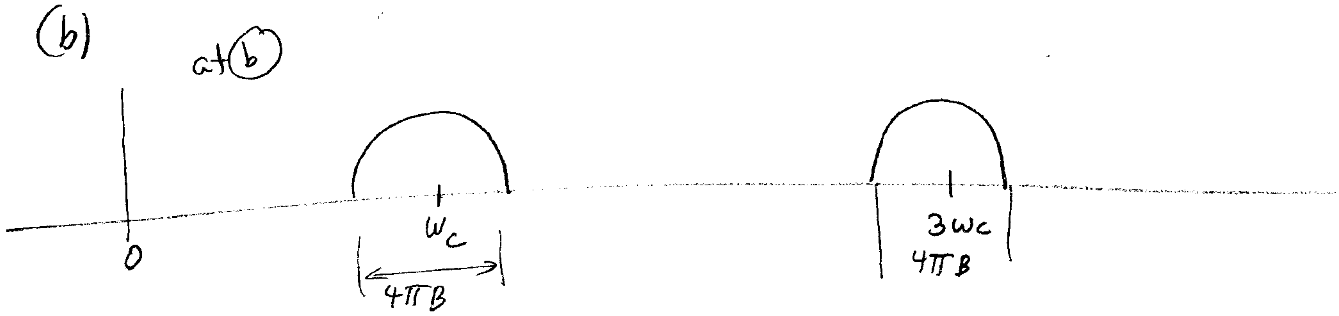
4.2-4 $\cos^3 \omega_c t$ =



Same frequency but distorted
so it can be used.

(a) The only filter required is a harmonic filter —
Low pass to reject the component at $3\omega_c$

(b)



(c) Min $\omega_c = 4\pi B$

(d) Would $\cos^2 \omega_c t$ work?
No - there is only second harmonic, no fundamental.
only $2\omega_c$ appears at output.

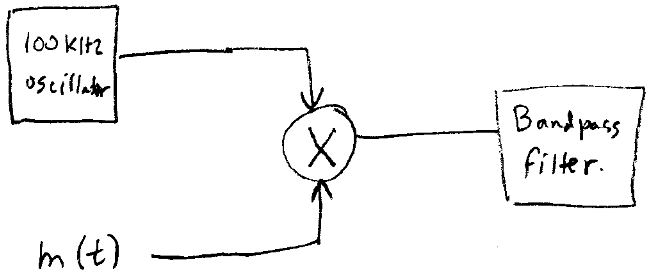
(e) only for odd n

4.2-5

Need $f_c = 300$ kHz

but have only 100 kHz, ring modulator, bandpass filter.

(a)



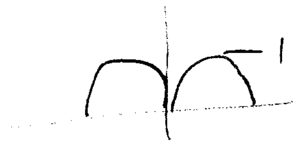
The ring modulator is used as a switching modulator, which generates odd harmonics.

So, tune the output to the third harmonic.

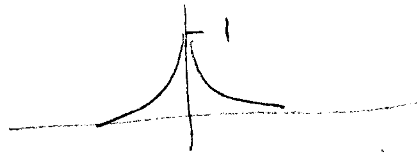
(b) $K = \frac{1}{3}$ -- the coefficient of the 3rd harmonic in a square wave.

4.2-8

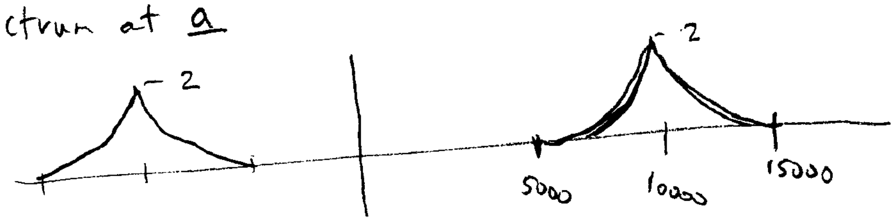
$M_1(\omega) =$



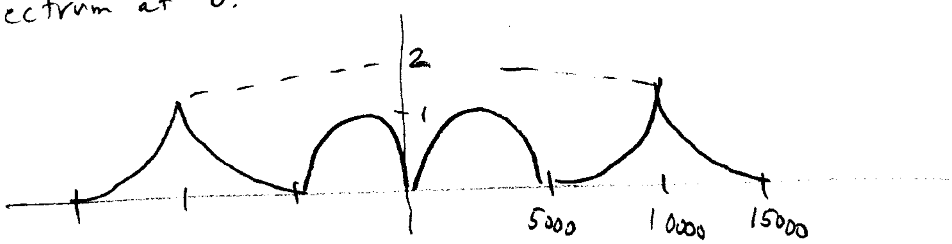
$M_2(\omega) =$



(a) spectrum at a

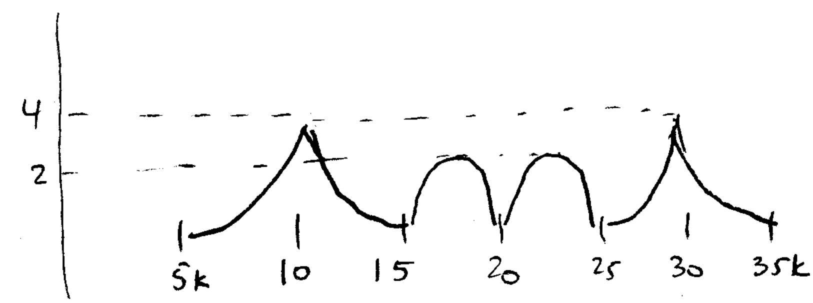


spectrum at b.



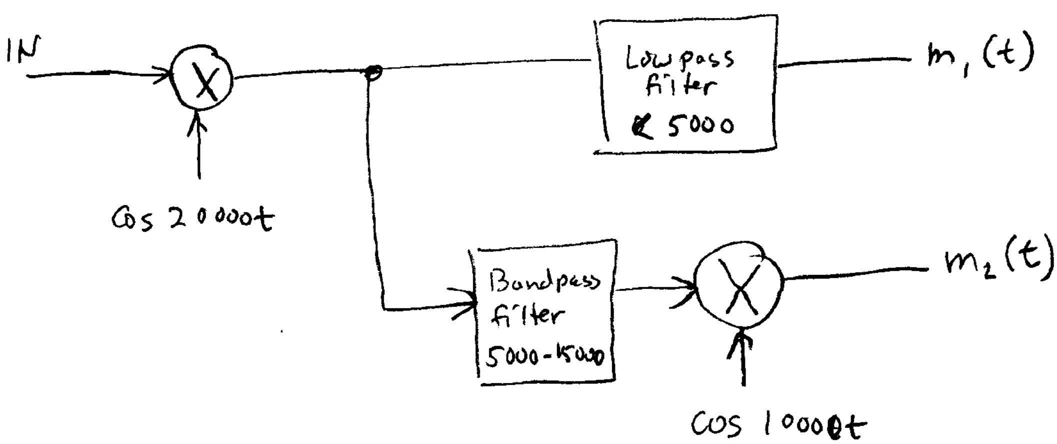
spectrum at c.

mirror.

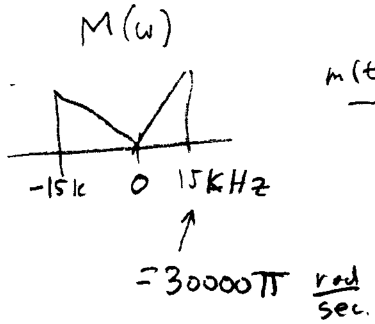


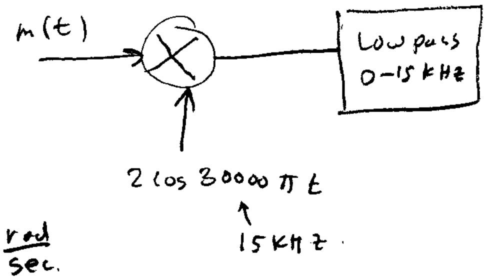
(b) channel bandwidth = 30000

(c) Receiver design

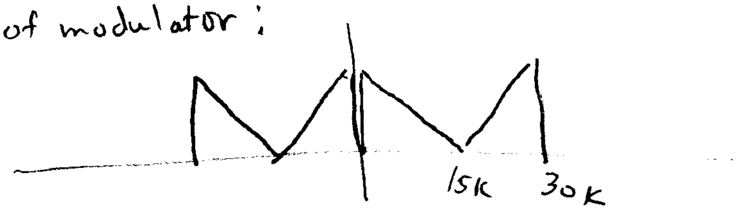


4.2-9



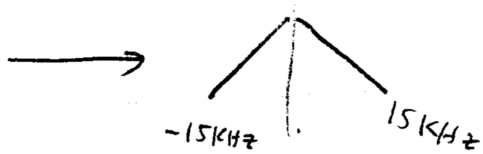


spectrum at output of modulator:



after lowpass filter

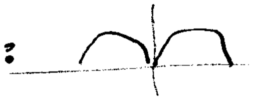
(a)



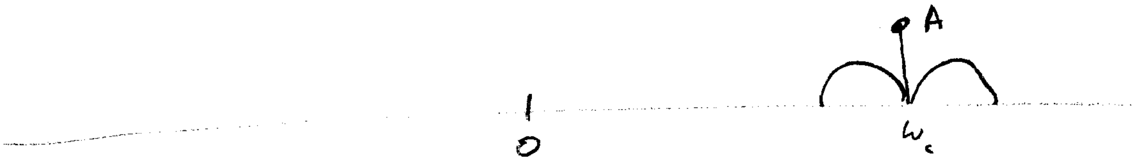
(b) To descramble, use the same system again

4.3-1

m(t) is:



Input spectrum



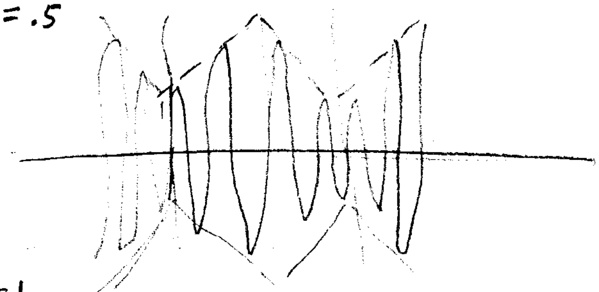
After demodulation + lowpass filter --

which is [A + m(t)]

4.3-2

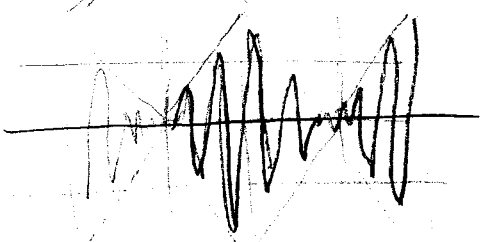
Ring modulation	plate modulation

(a) $\mu = .5$



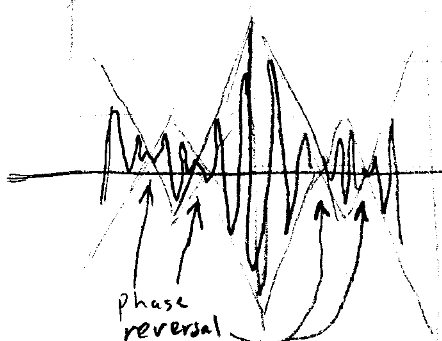
Same

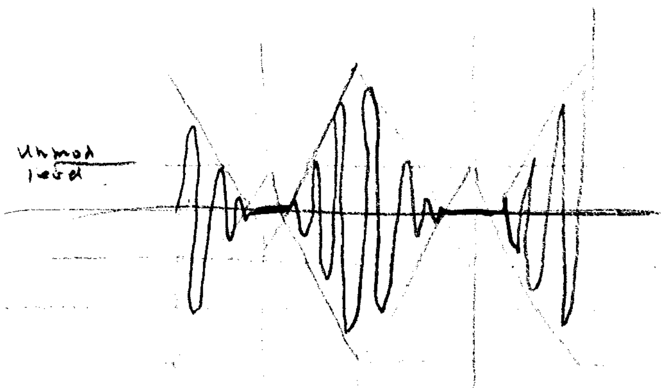
(b) $\mu = 1$



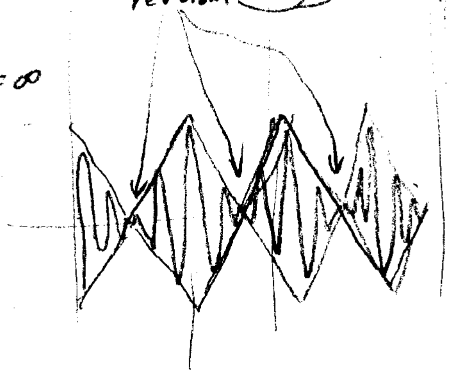
Same

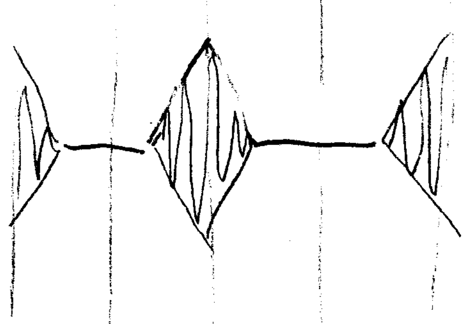
(c) $\mu = 2$





(d) $\mu = \infty$





4.3-3 For the signal in 4.3-2 with $\mu = 0.8$

(a) Find amplitude + power of the carrier

(b) Find sideband power, and power efficiency η

$$\phi_{AM} = \underbrace{A \cos \omega t}_{\text{Carrier}} + m(t) \cos(\omega_c t)$$

For $\mu = .8$, $A = \frac{M}{.8} = 1.25 B$ where M = peak magnitude of $m(t)$ = 10 here

(a) so $A = 12.5$ ← Amplitude of carrier

$P_c = \frac{A^2}{2} = 78.13$ ← power of carrier

$P_s = \frac{1}{2} \overline{m^2(t)}$ $\overline{m^2(t)} = \frac{(\mu A)^2}{2}$ would be for sine modulation.

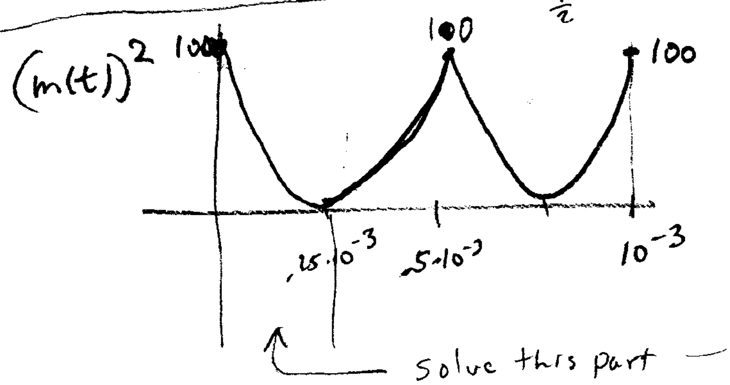
$= 25$ (wrong) $= \frac{(10)^2}{2} = 50$ ← is wrong,

Likewise $\eta = \frac{\mu^2}{2+\mu^2} = \frac{(.8)^2}{2+(.8)^2} = .24$ ← is also wrong

or $\eta = \frac{25}{78.13+25} = .24$

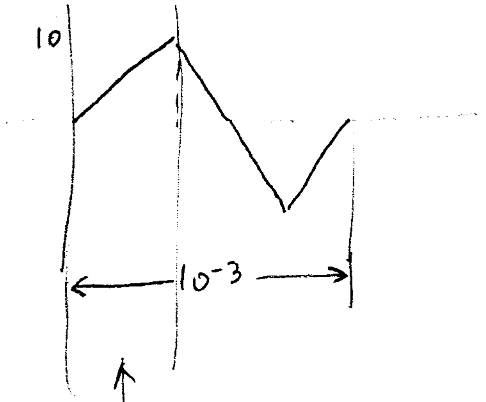
Power in sine wave $= \frac{A^2}{2}$

Power in triangle $= \lim_{T \to \infty} \frac{1}{T} \int_{-T/2}^{T/2} |g(t)|^2 \, dt.$



4.3-3 continued

$m(t)$:



in this region .. $m(t) = 40000\,t$

$(m(t))^2 = 1.6 \times 10^9 t^2$

$$P = \frac{1}{T}\int (m(t))^2\,dt$$

$$= \frac{1}{.25 \times 10^{-3}} \int_0^{.25 \times 10^{-3}} 1.6 \times 10^9 t^2\,dt$$

$$= \frac{1.6 \times 10^9}{.25 \times 10^{-3}} \int_0^{.25 \times 10^{-3}} t^2\,dt$$

$$= 6.4 \times 10^{12} \left[\frac{1}{3} t^3\right]_0^{.25 \times 10^{-3}} =$$

$$= (6.4 \times 10^{12})(5.208 \times 10^{-12})$$

$$\boxed{\widetilde{m^2(t)} = 33.33}$$

$$P_s = \frac{1}{2}\widetilde{m^2(t)} = 16.67$$

$$\eta = \frac{P_s}{P_s + P_c} = \frac{16.67}{78.13 + 16.67}$$

efficiency

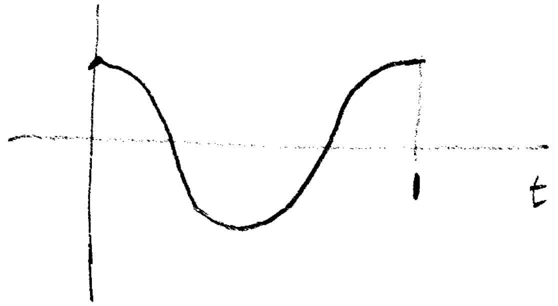
$$\boxed{= .18} \leftarrow \eta$$

4.3-4

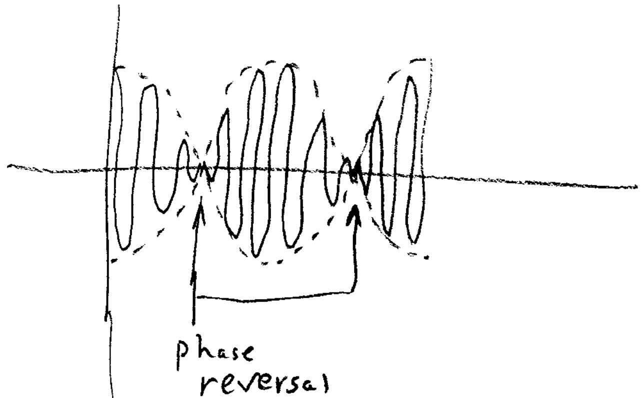
(a) DSB-SC corresponding to $m(t) = \cos 2\pi t$

(1 Hz)

$m(t) =$



Answer is:

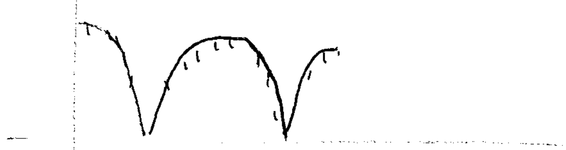


(b) $m(t) = \cos \omega_c t$, DSB-SC signal.

Show that output of envelope detector is $|m(t)|$ not $m(t)$

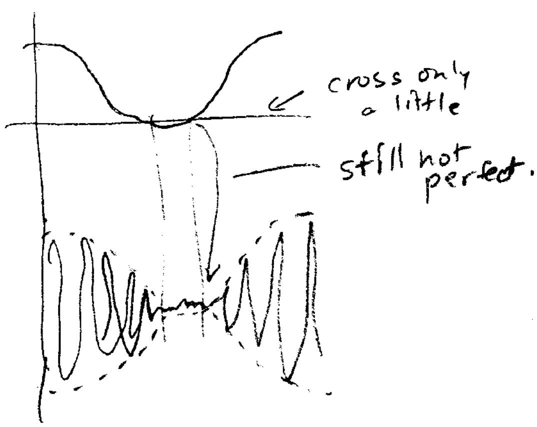
Envelope detector output -- Half wave rectifier on carrier.

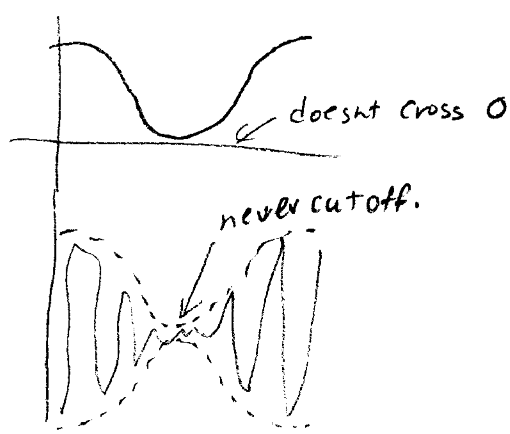
it can't see phase.



Add a carrier, it moves the zero point -

The carrier must be of sufficient strength to prevent zero crossings.





4.3-5 Show that any scheme for generating DSB-SC can also generate AM.

Add a DC component to m(t) so it never crosses through 0. — This is AM.

Conversely --- No. The usual scheme for generating AM will not generate DSB-SC.

The carrier just cuts off.

4.3-6 Show that any scheme for demodulating DSB-SC can also demodulate AM.

AM is just DSB-SC with a DC component.
The spectrum is the same except for the carrier.

Conversely; No -- When DSB-SC is fed to an envelope detector, the output is a full wave rectified version of m(t)

Questions 4,5,6 ---
"Show" ambiguity.
It could be interpreted as "show by math"
or "show by intuition"

You should be able to do both.